National Environmental Policy Act (NEPA)
ENVIRONMENTAL EVALUATION NOTIFICATION FORM

D R A F T

Grantee/Contractor Laboratory: BROOKHAVEN NATIONAL LABORATORY

Project/Activity Title: AGS Super Neutrino Beam Facility

CH NEPA Tracking No.: Type of Funding:

B&R Code: Total Estimated Cost: $369M FY03 Dollars

DOE Cognizant Secretarial Officer (CSO): James F. Decker, SC-1

Contractor Project Manager: Bill Weng Signature:
Date:

Contractor NEPA Reviewer: M. Davis Signature:

Date:

I. Description of Proposed Action:

This document briefly describes the accelerator and target systems for the AGS Super Neutrino Facility. Basically, the action is to build a wide-band neutrino beam generated by a 1 MW proton beam from the AGS. This action is coupled with a half megaton water Cerenkov detector located deep underground in the former Homestake mine in South Dakota. Using the AGS beam, scientists would be able to measure the complete set of neutrino oscillation parameters.

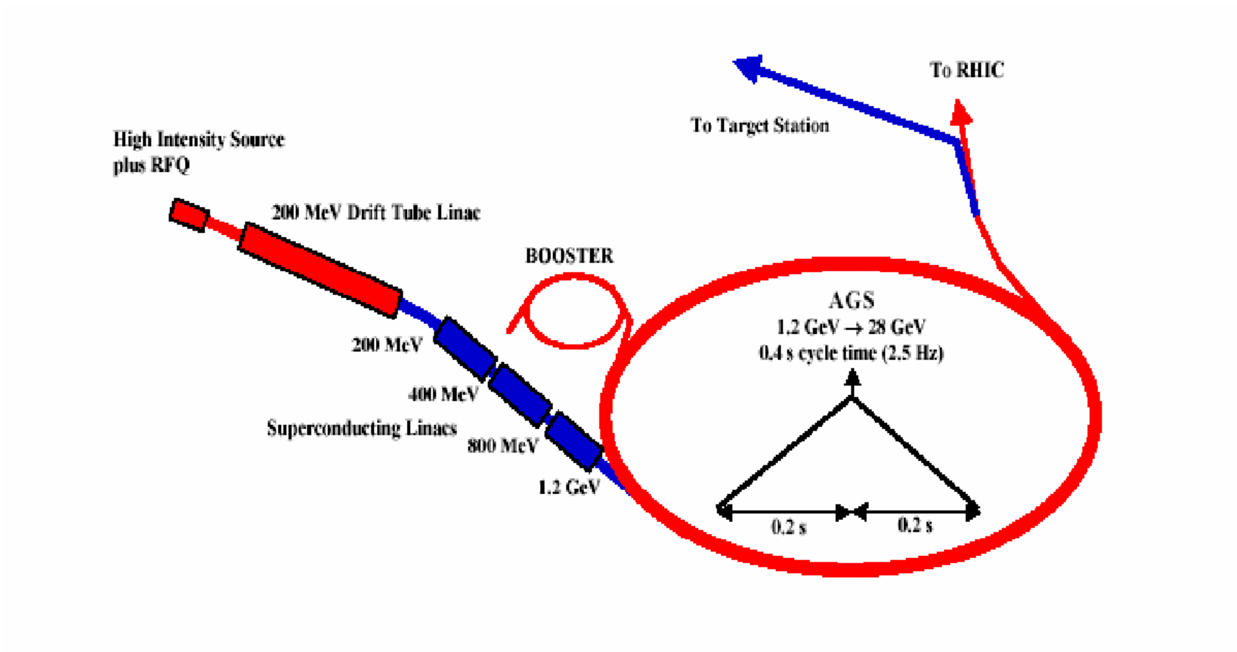
The major BNL components of this facility include a new 1.2 GeV superconducting linac, ramping the AGS at 2.5 Hz, and the new target station for 1.0 MW beam. The proposed action also calls for a moderate increase, about 30%, of the AGS intensity per pulse. Special care will be taken to account for all sources of proton beam loss. Adequate shielding and collimation of stray beam particles will ensure equipment reliability and personal safety.

The requirements for the proton beam, which will be used to create the super neutrino beam, are summarized in Table 1 and a layout of the upgraded AGS is shown in Figure 1. Since the present number of protons per fill is already close to the required number, the upgrade focuses on increasing the repetition rate and reducing beam losses in order to avoid excessive shielding requirements, and to maintain activation of the machine components such that residual dose rates are at workable levels.

Table 1 Performance of the Present and Upgraded AGS

Parameter	Present	Upgrade
Average Beam Power	0.14 MW	1.0 MW
Beam Energy	24 GeV	28 GeV
Average Beam Current	6 μA	36 μA
Cycle Time	2 sec	400 ms
Number of Protons per Fill	7.0E13	8.9E13
Number of Bunches per Fill	12	23
Protons per Bunch	5.8E12	3.72E12
Number of Injected Turns	190	240
Repetition Rate	0.5 Hz	2.5 Hz
Pulse Length	0.35 ms	0.72 ms
Chopping Rate	0.75	0.75
Linac Average/Peak Current	26/35 mA	21/28 mA

Figure 1 Layout of AGS



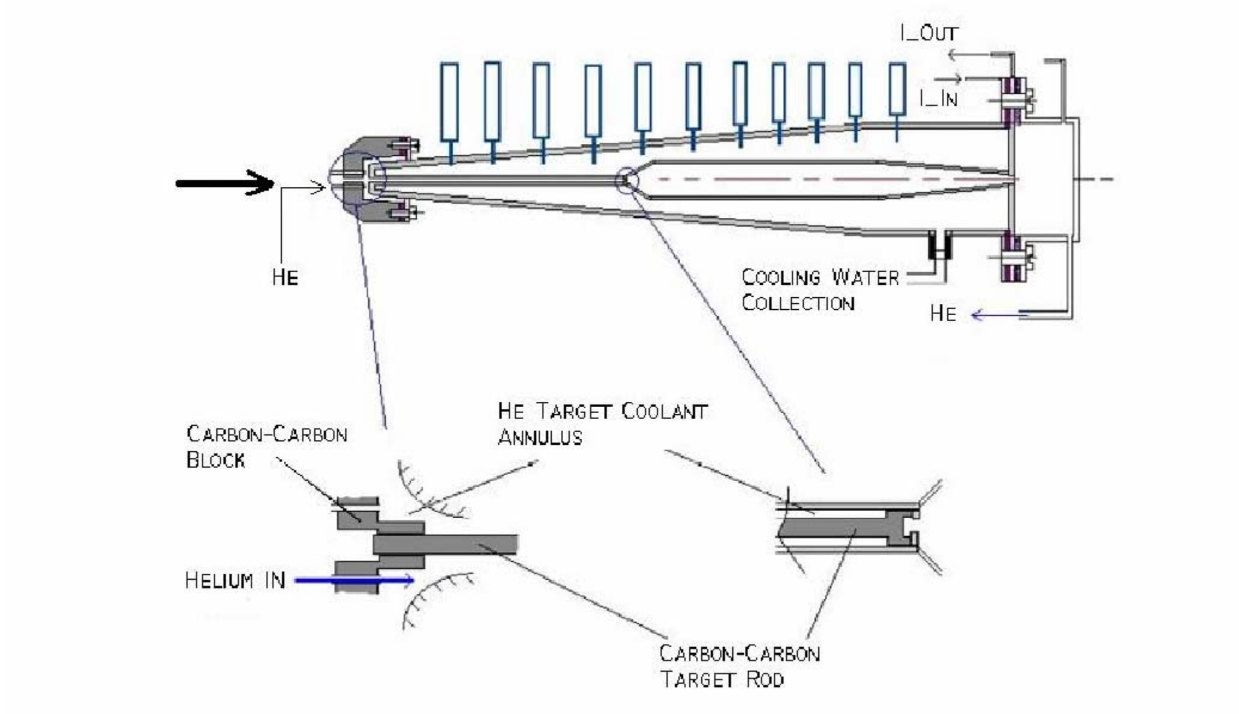
The AGS Booster is not well suited for high average beam-power operation. In order to minimize the injection time to about 1 msec, a 1.2 GeV linac will be used instead of the Booster. The 1.2 GeV linac consists of the existing warm linac of 200 MeV and a new superconducting linac of 1.0 GeV. The multi-turn H^- injection from the present linac source of 30 mA and 720 μ sec pulse width is sufficient to accumulate 8.9E13 particle per pulse in the AGS.

The minimum ramp time of the AGS to full energy is presently 0.5 s; this must be upgraded (shortened) to 0.2 s to reach the required repetition rate of 2.5 Hz. This requires an upgrade of the AGS power supply and the RF system.

The extracted proton beam uses an existing beam line at the AGS, but is then directed to a target station atop a constructed earthen hill.

The design of the target is shown in Figure 2. The material selected for the proton target is a carbon-carbon composite. It is a 3-dimensional woven material that exhibits extremely low thermal-expansion for temperatures up to 1000^0C; for higher temperatures it responds like graphite. This property is important for greatly reducing the thermo-elastic stresses induced by the beam, thereby extending the life of the target.

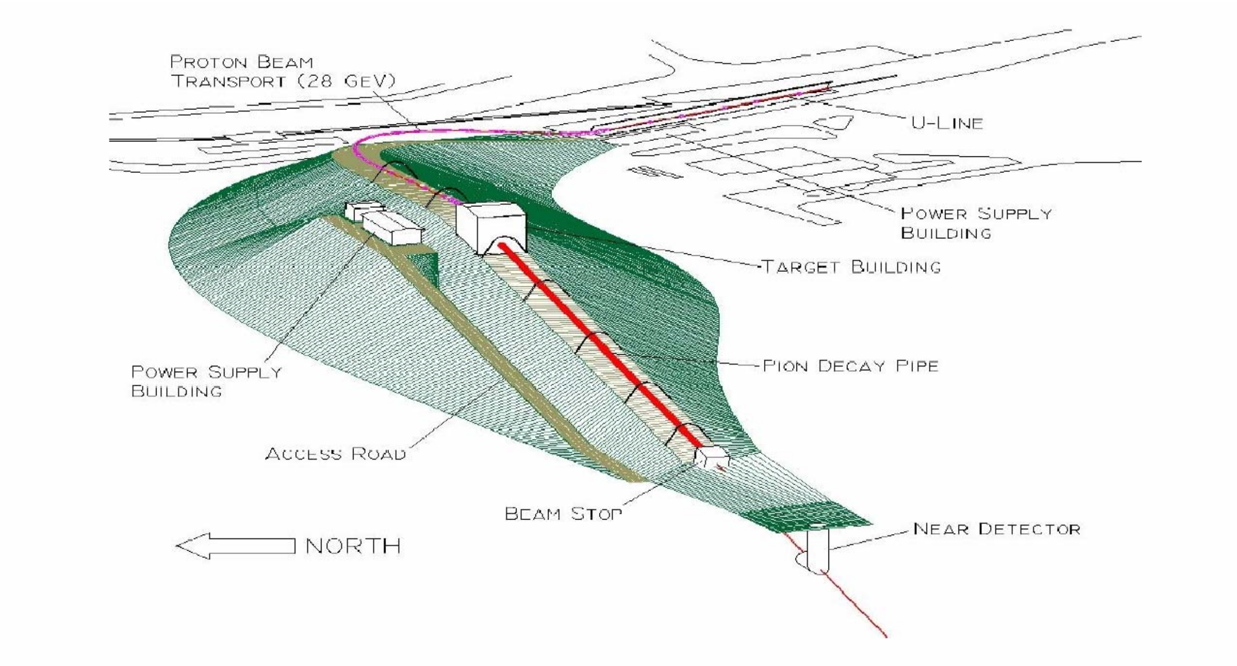
Figure 2 Target Configuration



The target consists of an 80 cm long cylindrical rod of 12 mm diameter. The target intercepts a 2 mm rms proton beam of 1E14 protons/pulse. The total energy deposited as heat in the target is 7.3 kJ with peak temperature rise of about 2800 ^{o}C. Heat will be removed from the target through forced convection of helium gas across the target's outside surface.

The target is followed by a downward sloping pion decay-channel. This vertical arrangement keeps the target and decay channel well above the water table in this area of the site. The 11-degree slope aims the neutrino beam at a water Cerenkov neutrino detector to be located in the Homestake mine at Lead, South Dakota. A plan view of the AGS facility is shown in Figure 3.

Figure 3 Plan View of Proposed AGS Super Neutrino Target Facility

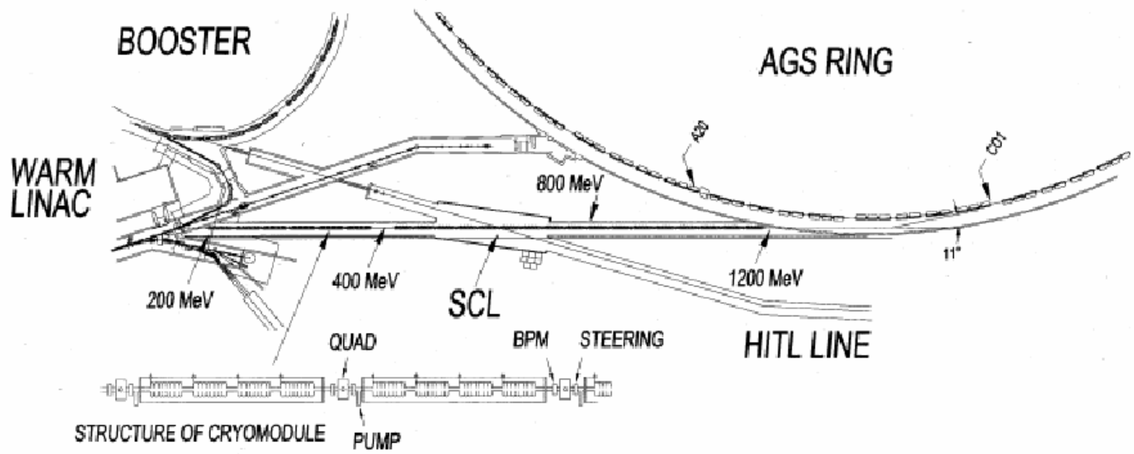


A project start year has not been defined and escalation cannot be estimated without a project start year. However, it is estimated that three years of research and development are needed to build prototypes and complete a detailed engineering design that will reduce cost and improve operational reliability. This will be followed by 4.5 years of construction and 0.5 year of commissioning to prepare the facility for physics research operations.

II. <u>Description of Affected Environment</u>:

The proposed location of the super-conducting linac (SCL) on the BNL site is shown in Figure 4. The beam leaves the present room-temperature linac at the energy of 200 MeV and, after a bend of 17.5 degrees, enters a new 120 m long tunnel, where the SCL is located, and joins the AGS ring at the location of magnet C01. The location of the SCL is within a zone of previously disturbed land. In order to protect groundwater from activated soil, a waterproof liner will be installed approximately 0.6 meters below the surface, and extend several meters on each side of the SCL.

Figure 4 Plan View of the 1.2 GeV Super Conducting Linac (SCL)



Although the average power will not be higher than now, the peak power required is approximately 110 MW, exceeding the 50 MW rating of the existing Siemens motor generator. A new motor generator capable of providing 100 MW will be installed.

While the average power of the AGS ring will increase, routine proton beam loss will be maintained at existing levels due to improvements in beam control. That is, the 1 MW upgrade of the AGS will require the C-A Department to reduce the fractional beam losses by the same amount as the beam power is increased. This means that the losses will be reduced by about a factor of ten (~ 10% to ~1%). This is the basis of the proposed design in particular the 1.2 GeV Linac. This means that not much more shielding of the AGS is required but more importantly the activation of the AGS is kept at the present level, which allows for manual maintenance. Some shielding may be added near hatches and fan houses to minimize fault levels of radiation. The beam will also be shut-off within one pulse, which will be ten times faster than present capability or within 0.4 seconds. The maximum dose of a failure under the newer capability is about the same as today. This requires new chipmunk area radiation monitors to be installed.

In order to protect groundwater from activated soil, a waterproof liner will be installed approximately 0.6 meters below the surface, and extend about 9 meters on each side of the AGS ring.

The proton beam will be extracted from the AGS and will use part of the RHIC beam transport line before exiting the decommissioned neutrino beam-line tunnel in a northerly direction and at an upward angle of approximately 13.8 degrees. The beam will bend towards the west by approximately 68.5 degrees, then down a total of 25.1

degrees to the proton target. The only major new radiation source will be at the carbon-carbon target and appropriate shielding will be employed at that location.

A large flux of secondary particles, pions and kaons, are created in the collision of extracted proton beam with the carbon-carbon target. For secondary particles, which are the neutrino parents, a focusing a magnetic horn is used. The horn is a coaxial magnetic lens which has high angular and momentum acceptance. After creation and focusing, the pions decay "on the fly" to a neutrino and to a muon. A 200-m pion-decay region follows the target with the neutrino beam entering the beam stop at 11.26 degrees to the horizontal. The on-site near detector facility, which detects neutrinos, is located 285 m from the target, 21 m below ground level. It is noted that neutrinos interact weakly with matter and will not activate the ground or the groundwater.

The vertical beam-geometry results in a hill 50-meters high at the apex of the proton beam. This geometry provides for the neutrino beam's 11.3-degree entry into the earth and avoids potential irradiation of soil by stray protons or neutrons close to the Long Island water table. An impermeable rain-water barrier will be installed to prevent rain-water penetration of potentially irradiated soil, which is consistent with present ground-water protection practices at BNL.

Existing utilities and roads will be relocated and approximately 726,350 cubic meters of sand will be placed forming the hill. The sand fill will be placed in 0.3 m lifts and compacted to 98% of its maximum density. The fill will be placed early in the project allowing it to settle for several years before re-excavation for placement of the tunnel. Approximately 330 m of 3-m diameter tunnel, overburdened with at least 6.0 m of fill will be required for proton transport. The impermeable rain-water barrier will be installed 0.6 m below the surface of the overburden.

Two power supply/utility buildings will be provided, one located low near the existing beam line, the other located high near the target area. These buildings will house power distribution systems, power supplies, water pumping systems, instrumentation and controls for the beam line. These are similar to the power supply/utility buildings already in use at the Collider-Accelerator complex.

In general, electrical power will be distributed around the site at 13.8 kV. Unit substations will transform the power into convenient voltages, typically 480 and 208/120 volts. Electrical power is divided into two major categories: conventional and experimental. Conventional power encompasses building power for lighting and convenience power for heating, ventilation, air conditioning, and miscellaneous equipment. Although there are no safety critical power needs, emergency power will be provided as required for smooth operations. Experimental power feeds all the power supplies for magnets and associated equipment such as, cooling-water pumps and cooling towers. All electric power distribution designs will follow the requirements of the National Electrical Code and industry standards.

The cooling water system will use a 3.5 MW cooling tower for primary heat rejection with four isolated, closed loop cooling systems for:

- All transport magnets
- Two power supply areas
- Horn cooling

Each system will contain redundant pumps, a heat exchanger, a full-flow filter and a side-stream deionizer. The system controls will be PLC based and be capable of monitoring and reacting to water leaks if they occur. All tritiated water systems will be in compliance with Suffolk County Article 12 requirements

Groundwater monitoring wells will be provided to insure compliance with all Local, State and Federal ground water protection requirements.

The target area will include the proton target, horns, horn power-supply and water-cooling system. A shielded storage area will be provided for radioactive component storage and repair. Modular concrete and steel shielding will provide radiation shielding. Access to the horn vault for installation and removal of the horns is accomplished by removing the modular shielding. Present plans call for hanging the horns from shielded supports with the ability to survey and connect or disconnect the horns from above the shield in a relatively low residual-radiation environment. The design of this area, as well as all areas, will incorporate the as-low-as-reasonably-achievable (ALARA) radiation protection principles. For example, an ALARA feature is a collimator downstream of horn #2, which will be installed to intercept a portion of the off-axis beam that would otherwise interact in the soil along the decay tunnel.

The decay tunnel will be a 2-m diameter steel tube that is 185-m long with seal welded joints. There will be a thin helium window at the downstream end of horn #2 and a helium window at the upstream end of the beam stop. The contained volume will be purged with helium gas. That is, the beam is designed so that it will not interact with air to create airborne radioactivity, which is another ALARA feature. Access to the upstream window will be provided through the target area. There will be no utilities or access to the decay tunnel between helium windows. The tunnel will be overburdened with 9 m of earth fill with a waterproof liner installed approximately 0.6 m below the surface, extending 9 m on each side of the tunnel. This liner will prevent groundwater contamination since some soil will be activated by beam.

The beam stop will be approximately 7-m wide, 7-m high and 9-m long. It will have a stepped foundation to approximate the 11.3-degree downward angle. The lowest portion of the beam stop will be approximately 3 m above the ground water table. The stop will consist mainly of existing steel plate from the decommissioned neutrino beam line that was built at the AGS in the 1960’s, and it will be overburdened with 4 m of soil. A waterproof liner will be placed 0.6 m below the surface of the soil to prevent rainwater from penetrating the beam stop area.

The near detector facility will be located 285 m from the target, 21 m below ground level. The facility will consist of welded steel tunnel sections 6-m in diameter, with a 5-m access shaft to the surface. A 9-m wide 15-m long service building will be constructed over the access shaft with a removable roof to access equipment below with a mobile crane. This building will contain electrical distribution, HVAC units, water-cooling systems, power supplies and experimental equipment associated with the detector. An elevator will be provided for accessing the detector from the service building. A unit substation and cooling tower will be provided for utilities in this area.

Since the facility is located below the water table, installation of the tunnel sections will involve excavation of soil to the water table, installation of sheet piling, excavation and dewatering of the sheet pile site, and installation of the tunnel sections. The tunnel is then seal welded and back-filled with soil.

The shielding policy for this facility is the same as that for the rest of the Collider-Accelerator facilities since the accelerator, beam-line, target and support buildings are to be the responsibility of the Department. Specifically, the Collider-Accelerator Department's Radiation Safety Committee will review facility-shielding configurations to assure that the shielding has been designed to:

- Prevent contamination of the ground water
- Limit annual site-boundary dose equivalent to less than 5 mrem
- Limit annual on-site dose equivalent to inadvertently exposed people in non-Collider-Accelerator Department facilities to less than 25 mrem
- Limit dose equivalent to any area where access is not controlled to less than 20 mrem during a fault event
- Limit the dose equivalent rate to radiation-workers in continuously occupied locations to ALARA but in no case would it be greater than 0.5 mrem in one hour or 20 mrem in one week
- Limit the annual dose equivalent to radiation workers where occupancy is not continuous to ALARA, but in no case would it exceed 1000 mrem.

In addition to review and approval by the Radiation Safety Committee, final shield drawings must be approved by the Radiation Safety Committee Chair or the ESHQ Associate Chair. Shield drawings are verified by comparing the drawing to the actual configuration. Radiation surveys and fault studies are conducted after the shield has been constructed in order to verify the adequacy of the shield configuration. The fault study methodology that is used to verify the adequacy of shielding is proscribed and controlled by Collider-Accelerator Department procedures.

III. <u>Potential Environmental Effects</u>: (Attach explanation for each "yes" response and "no" response if additional information is available and could be significant in the decision making process.)

A. Sensitive Resources: Will the proposed action result in changes and/or disturbances to any of the following resources?

		Yes/No
1.	Threatened/Endangered Species and/or Critical Habitats	No
2.	Other Protected Species (e.g., Burros, Migratory Birds)	No
3.	Wetlands	Yes
4.	Archaeological/Historic Resources	No
5.	Prime, Unique or Important Farmland	No
6.	Non-Attainment Areas	No
7.	Class I Air Quality Control Region	No
8.	Special Sources of Groundwater (e.g., Sole Source Aquifer)	Yes
9.	Navigable Air Space	No
10.	Coastal Zones (e.g., National Forests, Parks, Trails)	
11.	Areas w/Special National Designation (e.g., National Forests, Parks, Trails)	No
12.	Floodplain	No

B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated substances or activities?

		Yes/No
13.	Clearing or Excavation (indicate if greater than 5 acres)	Yes
14.	Dredge or Fill (under Clean Water Act section 404; indicate if greater than 10 acres)	No
15.	Noise (in excess of regulations)	No
16.	Asbestos Removal	No
17.	PCBs	No
18.	Import, Manufacture or Processing of Toxic Substances	No
19.	Chemical Storage/Use	Yes
20.	Pesticide Use	No
21.	Hazardous, Toxic, or Criteria Pollutant Air Emissions	No
22.	Liquid Effluent	Yes
23.	Underground Injection	No
24.	Hazardous Waste	Yes
25.	Underground Storage Tanks	No
26.	Radioactive (AEA) Mixed Waste	No
27.	Radioactive Waste	Yes
28.	Radiation Exposures	Yes

C. Other Relevant Disclosures. Will the proposed action involve the following?

		Yes/No
29.	A threatened violation of ES&H regulations/permit requirements	No
30.	Siting/Construction/Major Modification of Waste Recovery or TSD Facilities	No
31.	Disturbance of Pre-existing Contamination	No
32.	New or Modified Federal/State Permits	Yes
33.	Public controversy (e.g., Environmental Justice Executive Order 12898 consideration and other related public issues)	Yes
34.	Action/involvement of Another Federal Agency (e.g., license, funding, approval)	No
35.	Action of a State Agency in a State with NEPA-type law. (Does the State Environmental Quality Review Act Apply?)	No
36.	Public Utilities/Services	No
37.	Depletion of a Non-Renewable Resource	No

IV. **Section D Determination**: Is the project/activity appropriate for a determination by the OM under Subpart D of the DOE NEPA Regulations for compliance with NEPA?

A. **DOE-CH NEPA Coordinator Review**:

DOE-CH NEPA Coordinator Reviewer: ______________________________________

Signature:______________________________ Date:____________________

B. **DOE CH NCO NEPA Review**:

NCO Concurrence with Proposed Class of Action Recommended

CX EA EIS

Category____

DOE CH NCO Reviewer:____

Signature:______________________________ Date:____________________

DOE Recommendation Approvals:

CH NCO: ______________________________ Signature:_________________________

Date:_________________________

CH GLD: ______________________________ Signature:_________________________

Date:_________________________

CH ESHD: _____________________________ Signature:_________________________

Date:_________________________

CH AMST: _____________________________ Signature:_________________________

Date:_________________________

CH Office Mgr.: _______________________ Signature:_________________________

Date:_________________________

V. Additional Information

A3 While the proposed action would not have a direct affect on wetlands, portions of the area of effect would be within one-half mile of New York State designated freshwater wetlands. Therefore, BNL would submit an application for permit under the Wild, Scenic and Recreational River Systems Act to the New York State Department of Environmental Conservation (NYSDEC).

A8 Although BNL is situated over a Sole Source Aquifer, operation of these accelerator facilities should not affect the aquifer. This would include discharges to the BNL sanitary and storm water systems. The BNL Standards Based Management System Subject Area "Liquid Effluents" provides requirements related to discharges. Work planning, experimental review, and Tier I safety inspections are three examples of several methods used to ensure hazardous effluents would not make their way into the sanitary waste-stream or storm-water discharges.

B13 Excavation would be required to install the new buildings and the new piping associated with SCL, the proton transport tunnel, target area, decay tunnel, detector and cooling tower. Excavation would be limited to the area immediately adjacent to the buildings and the piping route. Standard construction techniques, such as silt-fences and/or straw-bales, would be used to control runoff during excavation. Excavated areas associated with piping would be backfilled and returned to grade.

B19 Routine operation and maintenance actions associated with the accelerator facilities would involve the use of chemicals or compounds, generally in small quantities. BNL's Chemical Management System would track the quantity, location, owner and storage of any chemical inventory.

B22 Any discharges associated with the proposed action, including cooling-tower effluent, would be managed according to the BNL Standards Based Management System Subject Area "Liquid Effluents".

B24 Routine operation and maintenance actions associated with the accelerator facilities would result in a small amount of hazardous wastes being generated, primarily cleaning compounds. The total volume generated would not be expected to exceed a few tens of cubic feet per year and would not constitute a significant increase to Collider-Accelerator Department total estimates. All hazardous wastes would be managed in accordance with established BNL procedures and subject areas. Work planning, experimental review, and Tier I safety inspections are three examples of several methods for ensuring wastes are minimized and controlled.

B27 Routine operation and maintenance actions associated with the accelerator facility would result in a moderate amount of radioactive waste being generated. The total volume generated would not be expected to exceed a few hundred cubic feet per year and would not constitute a significant increase to Collider-Accelerator Department total estimates. All radioactive wastes would be managed in accordance with established BNL procedures and subject areas. Work planning, experimental review, and Tier I safety inspections are three examples of several methods for ensuring wastes are minimized and controlled.

B28 Routine operation and maintenance actions associated with the accelerator facilities would result in low-level radiation exposures to workers. Interlocks, access controls, training and procedure administration would be used to minimize exposures and employ ALARA principles.

C32 Because portions of the affected area are within the one-half mile corridor of the Peconic River and are proximate to wetlands, BNL would submit to the New York State Department of Environmental Conservation an application for permit under the Wild, Scenic and Recreational River Systems Act. Depending on the disposition of the cooling-tower's discharge, the existing New York State Pollutant Discharge Elimination System (SPDES) permit would be revised as necessary. The proposed cooling system for the beam line would be a closed-loop de-ionized water system using ion exchange beds that would be removed for regeneration or disposal by a contractor off-site. At the proposed beam currents and energies induced activity would be expected in the cooling water that is used in closed-looped systems. This water would be collected and handled according to approved waste practices. Discharge of radioactive water or contaminants to the ground or to the sanitary system would be neither planned nor expected from the cooling systems. The closed-loop cooling system would be connected to a cooling tower via a heat exchanger. Cooling-tower waters would be treated either with ozone or with biocides and rust inhibitors, and would meet all SPDES effluent limits.

C33 Several issues may be controversial and include: 1) the potential to contaminate groundwater, 2) the visual impact of the proton beam line and target hill, 3) sky-shine radiation and 4) the underground off-site neutrino beam. In order to ensure activated soil shielding is protected from rainwater, impermeable caps will be installed over the low energy linac, superconducting linac, AGS ring, proton beam-line, decay tunnel and beam stop. Groundwater monitoring of the affected areas will be performed to ensure the integrity of the caps. In order to lessen the visual impact of the hill, the area will be re-vegetated as soon as practicable. Sky-shine radiation from the target area at the top of the hill, which may extend about 1000 meters if unabated, will be greatly reduced by applying appropriately thick shielding over the target. The fourth issue, which is the creation of an underground offsite neutrino beam, will require a campaign to educate stakeholders and the public about the neutrino and its infrequent interaction with matter.